



Mr Dan Meier
Water Acquisition Program
US Bureau of Reclamation
2800 Cottage Way
Sacramento, CA 95825

May 21, 2004

Dear Dan :

I recently completed an update of analysis I performed in 1997 related to potential water quality impacts in the San Joaquin River resulting from the delivery of Level IV water supply to refuges and private wetlands in the San Joaquin Basin. This update replaces two spreadsheet models; my original spreadsheet model developed in 1997 and a subsequent version published by Ch2M-Hill which presented the same basic data in a revised format. I chose to return to the original spreadsheet format in this new work, finding it easier to follow and explain, and have given it a name - WETMANSIM (Wetland Management Simulator). The model is being copyrighted and is currently in version 0.95.

The WETMANSIM model addresses some deficiencies in the previous spreadsheet models.

- Wetland flooded area was static - leading to potential errors in wetland evaporation, seepage and return flow volume.
- Water delivery estimates and land use were based on figures published in the San Joaquin Basin Action Plan, which are now out of date.
- Little time was spent talking to wetland managers and the water masters responsible for water operations in the federal, state and private wetland areas.

The current model reflects current operations in the federal, state and private wetland areas as provided by the following individuals :

- Scott Lower: Water Master, Grassland Water District
- Dale Garrison: Refuge Water Supply Coordinator, US Fish and Wildlife Service
- Bill Cook: Refuge Manager, Los Banos State Wildlife Area, California Department of Fish and Game
- John Beam: Refuge Supervisor, California Department of Fish and Game
- Paul Forsberg: Refuge Water Supply Coordinator, California Department of Fish and Game

This information was conveyed in early March 2004 during a number of working sessions, organized in both Sacramento and Los Banos. The working group decided on an average flood-up and drainage cycle for seasonal managed wetlands, average monthly seepage and evaporation estimates and how the supplemental Level IV water supply (water supply in addition to the base, Level -II allocation) was typically distributed by month. By "coloring" this

supplemental water supply it becomes clearer how this additional water is used within the wetland areas. Determination of when Level IV water supply is used on these seasonal wetland areas makes it easier to assess potential water quality impacts. Developing a consensus on this issue was an important outcome of this planning effort and has resulted in a more realistic planning tool.

Attached is a summary of assumptions that went into the development of WETMANSIM. This summary follows the parameter listing in each spreadsheet and follows the computational logic within the spreadsheet.

Please call me at 510 486-7056 or e-mail me at nwquinn@lbl.gov with any questions about the spreadsheet model or the model description.

Sincerely

Nigel W.T. Quinn, PhD, P.E.
Group Leader, Hydrologic Engineering Advanced Decision Support
Berkeley National Laboratory

WETMANSIM ASSUMPTIONS

parameter	units	Aug-Mar	Annual
1. flooded Surface Area	acres	2293	
2. ETO loss inches per month	inches		
3. mean rainfall	inches	6.9	9.4
4. porosity	percent	0.2	0.2
5. target pond depth	inches	9.1	6.2
6. fillable vadose zone depth	inches	6.9	8.6
7. potential seepage loss	inches	9.6	20.6
8. applied water - LEVEL-2/4	acre-feet	19000	19000
9. non-district inflow	acre-feet	0	0
10. flood wetlands	inches	80.5	80.5
11. make-up water	inches	42.7	42.7
12. applied irrigation	inches	0.0	10.5
13. end of month storage	inches		
14. wetland release	inches	76.2	84.8
15. runoff/ag spill & drainage	inches		
16. released/applied	percent		
17. EC of supply water	uS/cm		
18. TDS supply water	(mg/L)	603	645
19. TDS wetland discharge	(mg/l)	706	898
20. TDS ag runoff	(mg/l)		
21. total wetland discharge	acre-feet	10,387	11,540
22. wetland discharge salt load	(tons)	9,969	14,099
23. combined discharge to SJR	acre-feet	10,387	11,540
24. combined discharge TDS	(mg/l)	706	898

1. The flooded surface area was obtained from the wetland water managers for each wetland unit. This represents the best guess for a normal water year of the acreage of ponded water during each month. Scott Lower provided these numbers for the GWD, Dale Garrison for the federal Refuges and Bill Cook for the State Wildlife Areas. Wetland units are defined as follows : Grassland WD is considered one wetland unit combining the North and South Grassland WD wetland areas; San Luis National Wildlife Refuge Complex is divided into San Luis, West Bear Creek, East Bear Creek, Freitas, Salt Slough and Kesterson wetland units; Los Banos WMA, Volta WMA and China island WMA are considered separate wetland units.
2. ETO is the potential monthly water loss from each flooded wetland. The average ETO for the whole Grassland Ecological Area was provided by Scott Lower.

3. Mean monthly rainfall. This estimate is based on rainfall records from CIMIS stations in Panoche Water District and at Kesterson NWR and was supplied by Scott Lower.
4. Porosity. This parameter is used to help estimate the amount of water that is required to displace the air-filled pores in the vadose zone of the regional aquifer. A higher porosity of 0.3-0.4, typical of sands, would require more water to fill and thus the wetland would exhibit greater water losses during flood-up. Monthly seepage would also be high and reach a steady-state once the initial flooding had filled all available pores. A value of 0.2 was used for most wetlands – which is indicative of a tighter soil with a high clay fraction.
5. Pond depth. The monthly average pond depth in seasonal wetlands will rise during flood-up to a level known as “shooting depth” (about 12 inches), which is a water depth that attracts diving ducks and other bottom-feeding waterfowl. This depth was assumed to be the average ponding depth once flood-up was completed.
6. Fillable vadose zone depth. This depth specifies the depth of the vadose zone and therefore help to define the volume of fillable pores that must be filled before water can pond on the surface.
7. Potential seepage loss. This is calculated as : fillable vadose zone depth * porosity. It is the estimated depth of surface applied water that will move into the groundwater in any given month.
8. Applied water. The volume of water (acre-ft) diverted from surface channels and applied as groundwater to each wetland area. This quantity is greater for level IV water supply since it includes water allocated under CVPIA. Most incremental Level IV water is applied during the summer months and not uniformly distributed over the year. Monthly surface applied water for Level II and Level IV was developed in a series of open discussions including Scott Lower from GWD, Bill Cook and John Beam from CDFG and Dale Garrison from USFWS. Much of the discussion centered around coloring the water to determine which allocation of water was being used each month. Level IV water used after the month of April will less impact of South Delta agriculture than Level IV water used between Feb 1 and April 30.
9. Non-district inflow. The volume of return flows from adjacent agricultural land. This mostly applies to return flows from CCID and San Luis Canal Company that have historically been conveyed through Grassland WD channels. These flows are occasionally used in GWD and supplement Reclamation water deliveries to the District. Scott Lower provided these average volumes of non-project inflow.
10. Flood wetlands. The depth of water applied to the average flooded area during each month during flood-up. For ease of accounting the spreadsheet begins in August. In most years flood-up occurs in September to minimize evaporative losses that would occur if flood-up occurred earlier. Shooting depth is achieved at different times in different parts of each wetland area. It is used as a calibration variable in the spreadsheet model.
11. Make-up water. The depth of water added after initial flood-up to bring water level to the desired average depth within each wetland management area.

12. Applied irrigation. The depth of water applied in the late spring and early summer months after initial drawdown to encourage the propagation of desirable moist soil plants. These quantities were supplied by the water masters, Scott Lower for GWD, Bill Cook for CDFG and Dale Garrison to USFWS.
13. End of month storage. A calculated water depth equivalent to the remaining depth of water after accounting for inflows and outflows to the wetland management area : $EOMS = \text{flood wetlands} + \text{mean rainfall} - \text{potential evapotranspiration} - \text{seepage loss} - \text{target pond depth}$.
14. Wetland release. Calculated depth of water equivalent to the remainder when the monthly target pond depth is subtracted from the end of month storage depth. Is the equivalent depth of water returned to Mud or Salt Slough which discharge to the San Joaquin River. This can be converted to a volume by multiplying by the monthly average flooded surface area.
15. Runoff / ag spill. This water depth refers to any return flows generated during wetland irrigation. This volume is typically small owing to high evaporation during the late spring and early summer months.
16. Released/applied. The ratio of released water to water applied is expressed as a percentage. This is an index of wetland flushing – a higher percentage indicates a greater amount of wetland flushing.
17. EC of supply water. Most water applied to seasonal and permanent wetlands in the Grassland Ecological Area, other than groundwater pumping, derives from the Delta and is delivered via the Delta Mendota Canal. This EC is the average salinity (measured in umhos/cm) of the supply water. The monthly EC values were based on monitoring conducted by Quinn and others in the Volta wasteway and on personal observation of Scott Lower.
18. TDS of supply water. The ratio of EC to TDS varies depending on the salt composition of the water. For Delta water an average factor of 0.64 is used to convert EC to TDS.
19. TDS wetland discharge. Water ponded in seasonal and permanent wetlands is subject to evaporation resulting from wind energy and heat which remove pure water leaving saltier water behind. Dust and bird excreta also add to wetland salt loads. Evaporation increases in the summer months when temperatures are higher resulting in elevated wetland TDS concentrations.
20. TDS agricultural runoff. In cases where summer irrigation results in drainage runoff - the salinity of this runoff is elevated owing to dissolution of surface salts and solubilized bird guano. Runoff was assumed negligible in the model.
21. Total wetland discharge. Obtained by multiplying the wetland release depth of water by the flooded surface area.
22. Wetland discharge salt load. Obtained by multiplying the total wetland discharge (calculated in 21) by the TDS of wetland discharge and adjusting the total using a conversion factor to convert acre-ft * mg/l to tons of salt.
23. Combined discharge to the SJR. This number should be the same as 19 except in the case of the GWD where the return flow is a blend of the GWD wetland return flow and the surface return flows conveyed through GWD channels from

CCID and SLCC. The return flows from these Exchange Contractors typically improve the wetland drainage water quality providing dilution.

24. Combined discharge TDS. This also applies only to GWD and is the blended water quality when the wetland discharges and the agricultural surface return flows are combined.